

REMARKS

By the present amendment, 1 to 4, 7 and 9 are pending in the application.

Claims 1 to 4 are independent claims.

Claim Amendments

Independent claims 1, 2, 3 and 4 have been amended to clearly specify that the oil country tubular goods of the present invention have only bainitic ferrite or bainite alone or in combination.

This is supported in the specification, e.g., at page 17, line 30 to page 18, line

1. Note that page 18, line 1 discloses that this claimed microstructure is “100%” by observation with an optional microscope.

Note that the term “comprised” has also been deleted from the last paragraph of independent claims 1, 2, 3 and 4.

§103

Claims 1 to 4, 7 and 9 were rejected under 35 U.S.C. §103(a) as being unpatentable over U.S. Patent No. 4,772,771 in view of U.S. Patent No. 6,245,290.

Claims 1 to 4, 7 and 9 were rejected under 35 U.S.C. §103(a) as being unpatentable over Japan No. 6-184693 (406184693) or U.S. Patent No. 6,245,290.

The rejections, as applied to the amended claims, are respectfully traversed.

The Present Invention

The present invention provides oil country tubular goods excellent in collapse characteristics after expansion, where the oil country tubular goods consisting essentially of, by wt%, C: 0.03 - 0.3%, Si: 0.8% or less, Mn: 0.3 - 2.5%, P: 0.03 or less, S: 0.01% or less,

Nb: 0.01 - 0.3%, Ti: 0.005 - 0.03%, Al: 0.1% or less, and N: 0.001 - 0.01%, and the balance Fe and unavoidable impurities, characterized in that a ratio of collapse pressure after expansion and collapse pressure before expansion is in the range of a/b: 0.85 to less than 1.0, where

a: collapse strength (MPa) after expansion 10 to 20% and b: collapse strength (MPa) of unexpanded steel pipe of same dimensions as steel pipe measured for a, said oil country tubular goods have a hot rolled structure having a low temperature transformation phase of only bainite ferrite or bainite alone or combined.

Patentability

U.S. Patent No. 4,772,771 (“US ‘771”)

The Office Action takes the position that the ‘771 patent discloses an electric seam welded steel pipe for oil-well use having good resistance to collapse pressure and souring, and further discloses a similar steel pipe composition and production process.

Applicants respectfully disagree.

In the ‘771 patent, a hot-rolled steel plate is quenched, and coiled below 250°. Then, the plate is formed into pipe, and then tempering is carried out on the thus formed pipe. Therefore, the obtained metallic structure of the pipe of the ‘771 patent contains tempered martensite, which is quite different metallic structure of the present invention. On the other hand, according to the present invention, although a hot-rolled steel plate is coiled below 300°, the steel pipe of the present invention does not contain martensite. It is submitted that there is a big difference between the cooling rate of the ‘771 patent and that of the present invention.

Regarding quenching, the '771 patent clearly discloses that "Next, the cooling conditions following the hot rolling will be described. For the purpose of quenching the steel, the cooling rate should be as high as possible." (Column 2, lines 38 - 40). Attached hereto as Attachment A is Metals Handbook Ninth Edition, Volume 4, pages 33-43. "Metals Handbook Ninth Edition" (page 34) discloses that a main object of quenching is to form martensite structure in the steel. Therefore, the quenching rate should be as high as possible. Accordingly, a metallic structure obtained by '771 patent is definitely tempered martensite as a main phase.

On the other hand, the metallic structure obtained by the present invention is only one or more of a bainitic ferrite or bainite structure. This metallic structure of the present invention can be obtained by a slow cooling rate which is slower than a quenching rate. Metals Handbook (Attachment A) discloses that if the cooling rate is slower than the quenching rate, bainitic structure can be obtained. This is clearly seen on page 33, Fig. 3 (relationship between the cooling rate and metallic structure to be obtained) in Metals Handbook. The cooling curve A represents the '771 patent and obtains martensite structure. On the other hand, the cooling curve B represents the present invention. As mentioned above, the cooling rate according to the present invention is much slower than the quenching speed (rate) = curve A in Fig. 3 at page 33 of Metals Handbook in order that the present invention has a bainitic ferrite or bainite structure. Therefore, the present invention is different from the technology disclosed or suggested in the '771 patent in the point of the cooling rate after hot-rolling and the metallic structure of the oil country tabular goods.

Although the Office Action asserts that both of the processes are similar based on the description on page 16 of the present specification, the description on page 16, lines

11 - 25, discloses a quench and temper for the welded parts, not that of the entire pipe. Therefore, the metallic structure of the pipe defined in the present invention does not exhibit a martensite structure.

U.S. Patent No. 6,245,290 (“US ‘290)

The technology disclosed in the ‘290 patent relates to a high-strength steel having excellent toughness throughout its thickness. However, in US ‘290, as the Office Action recognizes at page, paragraph 7, the metallic structure of US ‘290 is bainite and martensite. The present invention excludes a martensite structure. Therefore, the ‘290 patent is different from the present invention.

Japan No. 6-184693 (“US ‘693”)

The technology disclosed in the ‘693 patent relates to a Mo type ultra high strength electric resistance welded tube produced by quench-and-temper treatment and specifies finish rolling and cooling temperature. However, as the Office Action recognize at page 3, paragraph 7, the metallic structure of JP ‘693 is bainite and martensite. The present invention excludes a martensite structure. Therefore, the ‘693 patent is different from the present invention.

It is therefore submitted that independent claims 1 to 4, and all claims dependent thereon, are patentable over US ‘771, US ‘290 and/or JP ‘693 taken alone or in combination.

CONCLUSION

It is submitted that in view of the present amendment and foregoing remarks, the application is now in condition for allowance. It is therefore respectfully requested that the application, as amended, be allowed and passed for issue.

Respectfully submitted,

KENYON & KENYON LLP



By John J. Kelly, Jr.
Reg. No. 29,182

KENYON & KENYON LLP
One Broadway
New York, NY 10004
212-425-7200

ATTACHMENT A

Metals Handbook® Ninth Edition

Volume 4 Heat Treating

Prepared under the direction of
the ASM Handbook Committee

Planned, prepared, organized
and reviewed by
the ASM Heat Treating Division
Council

Planning Committee

**Lester E. Alban
James R. Easterday
Daniel S. Zamborsky**

**William H. Cubberly, Director of
Reference Publications
Vicki Masseria, Managing Editor
Craig W. Kirkpatrick, Associate
Editor
Bonnie Sanders, Editorial/Production
Assistant**



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METALS PARK, OHIO 44073

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First printing, November, 1981

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Comments, criticisms and suggestions are invited, and should be forwarded to the American Society for Metals.

Library of Congress Cataloging in Publication Data

American Society for Metals

Heat treating.

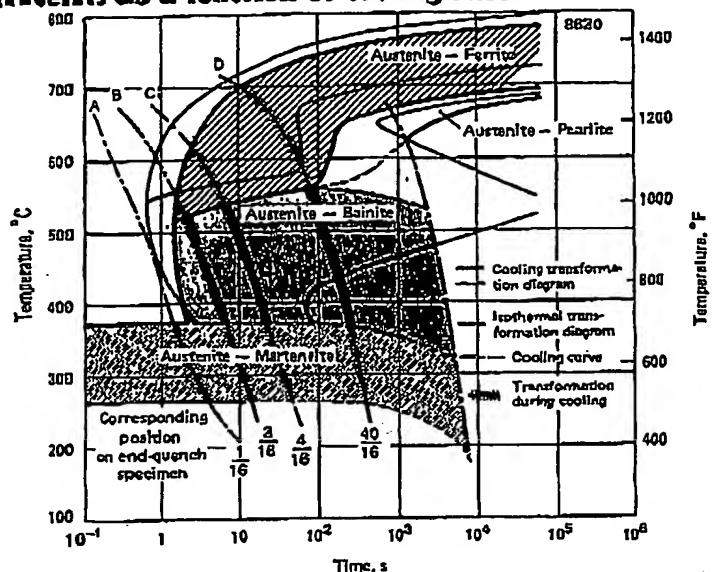
Metals handbook; 9th ed., v. 4)

Includes bibliographical references and index.

1. Metals—Heat treatment. I. American Society
for Metals. Handbook Committee. II. American Society
for Metals. Heat Treating Division. III. Series.
TA459.A5 9th ed., vol. 4 [TN672] 669s 81-12692
ISBN 0-87170-010-7 {671.2'6) AACR2

Printed in the United States of America

Fig. 3 Transformation diagrams and cooling curves for 8630 steel, indicating the transformation of austenite to other constituents as a function of cooling rate



used, to avoid soaking or the necessity for a protective atmosphere. A high speed recorder is used for plotting temperature changes as measured by one or more thermocouples embedded in the test piece. The resulting time-temperature curve indicates the heat transfer characteristics of the quenching fluid.

The typical surface and center cooling curves shown in Fig. 2 graphically describe the four stages of heat transfer from a hot solid to a cold liquid.

Stage A' in Fig. 2 illustrates the first effects of immersion. Sometimes called the "initial liquid contact stage", this stage is characterized by the formation of vapor bubbles that precedes the establishment of an enveloping vapor blanket. Stage A' lasts for only about 0.1 s and is relatively unimportant in the evaluation of heat transfer characteristics. It is detectable only when extremely sensitive equipment is used, and it cannot be detected when the liquid is viscous or contains entrained gases, or when the bath is operated at a temperature near the boiling point of the liquid.

Stage A, called the "vapor blanket cooling stage", is characterized by the Leidenfrost phenomenon—namely, the formation of an unbroken vapor blanket that surrounds the test piece. It occurs when the supply of heat from the surface of the test piece exceeds the

amount of heat needed to form the maximum vapor per unit area of the piece. This stage is one of slow cooling, because the vapor envelope acts as an insulator and cooling occurs principally by radiation through the vapor film. This stage is not detectable in aqueous solutions of nonvolatile solutes (at about 5% concentration) such as potassium chloride, lithium chloride, sodium hydroxide or sulfuric acid. Cooling curves for these solutions start immediately with stage B.

When (a) saturated solutions of barium hydroxide, calcium hydroxide or other slightly soluble materials, (b) solutions containing finely dispersed solids, or (c) colloidal solutions in water are used, films are deposited on the test piece during the A stage, which results in the prolongation of both the A and C stages. This condition usually causes a more violent action in stage B. Solutions of some colloids or gels, such as polyvinyl alcohol, gelatin, soap and starch (but not water glass), form an envelope of gel outside the vapor blanket formed in stage A. The presence of this gel envelope prolongs the A stage and succeeding stages.

Stage B, the "vapor transport cooling stage", which produces the highest rate of heat transfer, begins when the temperature of the surface metal has been reduced somewhat and the continuous vapor film collapses; violent boil-

ing of the quenching liquid then occurs and heat is removed from the metal at a very rapid rate, largely as heat of vaporization. The boiling point of the quenchant determines the conclusion of this stage. Size and shape of the vapor bubbles are important in controlling duration of stage B, as well as the cooling rate developed within it.

Stage C is called the "liquid cooling stage"; the cooling rate in this stage is slower than that developed in stage B. Stage C begins when the temperature of the metal surface is reduced to the boiling point (or boiling range) of the quenching liquid. Below this temperature, boiling stops and slow cooling takes place thereafter by conduction and convection. The difference in temperature between the boiling point of the liquid and the bath temperature is a major factor influencing the rate of heat transfer. Viscosity also affects cooling rate in stage C.

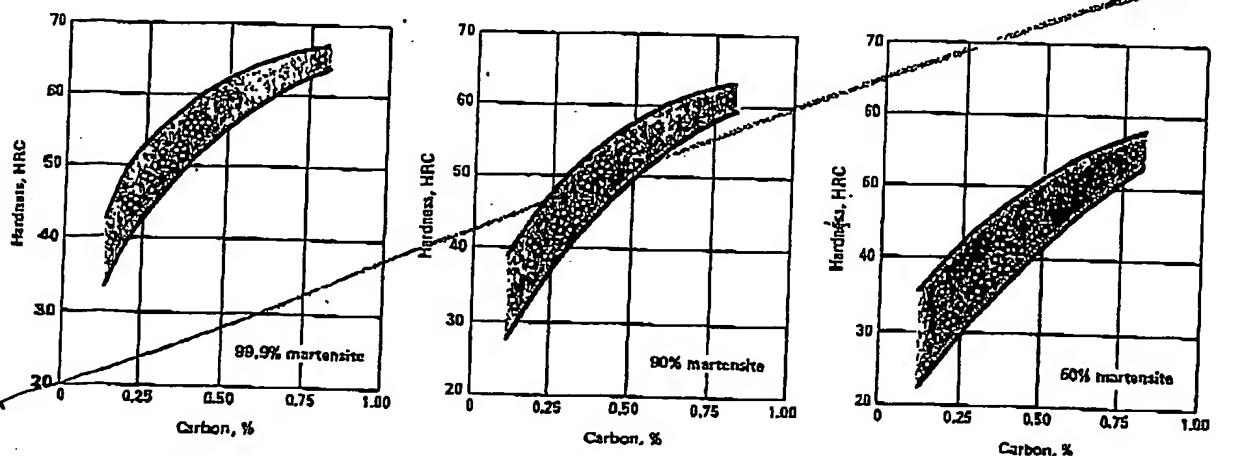
Significance of Cooling Curves.

The same mechanism is involved in cooling a test piece to evaluate a quenchant as is involved in quenching an actual part in a heat treating operation. For, all or any selected portions of the cooling curve information can be translated into cooling rate (in degrees per second), if desired. Although a cooling curve relates only to the size and material of the test piece, the thermocouple location, and conditions of the quenching liquid under which a test was performed, cooling curve data developed under one set of conditions can be translated to other conditions, as well as to H-values, by the application of heat transfer formulas.

Agitation is externally produced movement of the quenching liquid relative to the part, either by stirring the liquid or moving the part, or both in combination. This activity has an extremely important influence on the heat transfer characteristics of the quenching liquid. It causes an earlier mechanical disruption of the vapor blanket in stage A and produces smaller, more frequently detached vapor bubbles during the vapor transport cooling stage (stage B). It mechanically disrupts or dislodges gels and solids, whether they are on the surface of the test piece or suspended at the edge of the vapor blanket, thus producing faster heat transfer in liquid cooling (stage C). In addition to the above effects, agitation also brings cool liquid to replace heat-laden liquid.

34/Heat Treating of Steel

Fig. 4 Relation of carbon content and percentage martensite to HRC hardness



Temperature of Quenchant. The temperature of the liquid may markedly affect its ability to extract heat. As an example, water temperature is very important because it loses its cooling power as it approaches its boiling point. In oil, this effect is not as pronounced because oil becomes less viscous as the temperature is increased. This "thinning" of the oil offsets the temperature rise by a substantial amount.

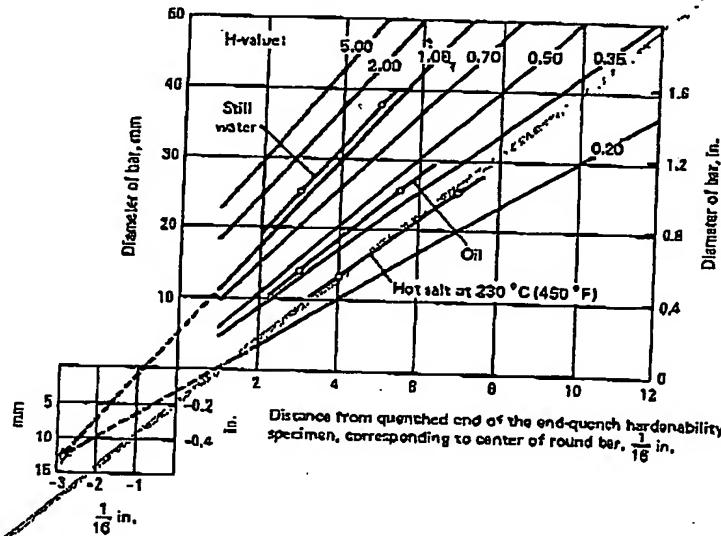
Workpiece Temperature. Increasing the temperature of the test piece has relatively little effect on its ability to transfer heat to the quenchant. The rate of heat transfer may be increased simply because a greater temperature difference exists. The most noticeable change in ability to transfer heat probably comes from the more rapid oxidation of the surface of the test piece at higher temperatures. This can either increase or decrease the heat transfer ability, depending on the thickness of the oxide developed.

Metallurgical Aspects

Steel is quenched to control the transformation of austenite to desired microconstituents. The microstructures that may be secured are indicated in Fig. 3. Martensite is the as-quenched microstructure usually desired. As indicated by curve A in Fig. 3, to obtain the maximum amount of martensite, the cooling rate must be fast enough to avoid the nose of the time-temperature transformation (TTT) curve of the steel.

being quenched. If the cooling rate is not fast enough to miss the nose of the TTT curve (curves B, C and D in Fig. 3), some transformation to bainite, pearlite or ferrite will take place, with a corresponding decrease in the amount of martensite formed and the hardness developed.

Fig. 5 Grossmann chart relating bar diameter, hardenability of steel and severity of quench



H-value (severity of quench): 5.00, strong brine quench, violent agitation; 2.00, poor brine quench, no agitation; 1.00, poor water quench, no agitation; 0.70, strong oil quench, good agitation; 0.50, good oil quench, good agitation; 0.35, good oil quench, moderate agitation; and 0.20, poor oil quench, no agitation

Carbon Content and Hardenability. The maximum hardness obtainable in a steel quenched at a sufficient rate to avoid the nose of the TTT curve depends on the carbon content. The cooling rate (quenching efficiency) necessary to obtain a fully martensitic structure depends on the hardenability